AN EXPERIMENTAL TEST OF THE EXISTENCE OF WHITTAKER'S *g* AND *f* FLUXES IN THE VACUUM

ABSTRACT

Whittaker has shown that the electromagnetic entity in vacuo consists fundamentally of two longitudinally directed magnetic fluxes, $\boldsymbol{g}$ and $\boldsymbol{f}$, which are physical and produce measurable effects in theory. In this paper, an experiment is proposed in which the physical nature of $\boldsymbol{g}$ and $\boldsymbol{f}$ can be tested when there are no fields and vector potentials present. The only entity present under the experimental design conditions is a physical scalar potential, which quantizes to a physical time-like photon.

INTRODUCTION

Superpotential theory was initiated by Whittaker {1,2}, who showed that the electromagnetic entity under all conditions can be described by two longitudinally directed magnetic fluxes, $\boldsymbol{g}$ and $\boldsymbol{f}$, from which electric and magnetic fields are obtained by double differentiation. In this paper, an experimental design is proposed to test whether $\boldsymbol{g}$ and $\boldsymbol{f}$ are physical and gauge invariant, or unphysical. A successful demonstration of the physical nature of $\boldsymbol{g}$ and $\boldsymbol{f}$ will indicate that, in the vacuum, there are longitudinal waves present, as well as the transverse waves of the received view {3-5}. The magnetic fluxes $\boldsymbol{g}$ and $\boldsymbol{f}$ cannot exist physically without a magnetic flux density being present in a beam of finite radius. Such a longitudinally directed magnetic flux density has been proposed {6-10} and referred to as the $\boldsymbol{B}^{(3)}$ component of radiation, a component of O(3) gauge theory applied to electrodynamics.

EXPERIMENTAL DESIGN

The experimental design is very simple. Two dipole antennae are set up in close proximity so that the vector potentials $\boldsymbol{A}_1$ and $\boldsymbol{A}_2$ from each antenna cancel:

$$\boldsymbol{A}_1 = -i\frac{\kappa e^{i\kappa r}}{4\pi c\varepsilon_0 r}\boldsymbol{p}_1 \tag{1}$$

$$\boldsymbol{A}_2 = i\frac{\kappa e^{i\kappa r}}{4\pi c\varepsilon_0 r}\boldsymbol{p}_2 \tag{2}$$

Here $\boldsymbol{p}_1$ and $\boldsymbol{p}_2$ are the dipole moments of each antenna, κ is the wave-vector magnitude, r is the radius vector magnitude, ϵ_0 is the vacuum permittivity and c the speed of light in vacuo. The expressions are therefore in S.I. units.

The principle of the experiment is therefore very simple. We have:

$$\boldsymbol{A} = \boldsymbol{A}_1 + \boldsymbol{A}_2 = 0; \qquad \boldsymbol{E} = 0; \qquad \boldsymbol{B} = 0; \tag{3}$$

so there are no vector potentials or fields present in the vacuum. Also, Whittaker's $\boldsymbol{f}$ and $\boldsymbol{g}$ vector functions are equal in magnitude but opposite in direction:

$$\boldsymbol{g}_1 = -\boldsymbol{g}_2; \qquad \boldsymbol{f}_1 = -\boldsymbol{f}_2. \tag{4}$$

However, the scalar magnitude of $\boldsymbol{g}$, denoted G, from both antennae is the same, and the sum of G from both antennae is {11-14}:

$$2G = \frac{2}{\sqrt{2}} A^{(0)} \left(X - iY\right) e^{i(\omega t - \kappa Z)}. \tag{5}$$

The scalar potential from $2G$ is therefore {11-14}:

$$\phi_L = 2\dot{G} \tag{6}$$

and obeys the massless Klein-Gordon equation:

$$\Box \phi_L = 0. \tag{7}$$

It can be shown {11-14} that canonical quantization of (7) leads directly to an ensemble of massless bosons which are physical time-like photons, each of energy $\hbar\omega$. The complete classical energy in the electromagnetic entity emanating from the double dipole antenna is:

$$H = \frac{2}{\mu_0} \int \boldsymbol{B}^{(3)} \bullet \boldsymbol{B}^{(3)} dV \tag{8}$$

where $\boldsymbol{B}^{(3)}$ is the Evans-Vigier field {6-10}.

DISCUSSION

When all vector potentials and fields are eliminated, the energy (H) should be detectable by a bolometer, even though there are no vector potentials or fields present. This would demonstrate the physical nature of f and g in the vacuum. Recent theoretical work suggests that the fluxes g and f are physical. The experiment would also demonstrate in another way the physical nature of $\boldsymbol{B}^{(3)}$, which has already been shown to be physical in several other ways {6-10}. Since G is a propagating wave, it travels through the vacuum, and when it meets matter, the d'Alembert condition (7) may no longer hold, so fields may reappear upon interaction with matter, specifically a single electron. This would be an interaction between a physical time-like photon and an electron, producing, perhaps, a photoelectric effect and measurable electric fields. If the logic of Whittaker's papers is followed, there can exist physical time-like photons in the vacuum without fields or vector potentials. Apart from the need to invoke the longitudinal flux density $\boldsymbol{B}^{(3)}$, this is a result of the Maxwell-Heaviside equations which therefore produce longitudinal scalar waves in the vacuum.

SCALAR INTERFEROMETRY

When two scalar beams of the type:

$$G_1 = \frac{A^{(0)}}{\sqrt{2}} \left(X - iY\right) e^{i(\omega t - \kappa Z_1)} \tag{9a}$$

$$G_2 = \frac{A^{(0)}}{\sqrt{2}} \left(X - iY\right) e^{i(\omega t - \kappa Z_2)} \tag{9b}$$

interfere, their combined energy density in the zone of interference is easily shown to be:

$$\frac{En}{V} = \frac{cI}{R^2 \omega^2} \left[1 + \cos\left(\kappa \left(Z_1 - Z_2\right)\right)\right] \tag{10}$$

where I is the combined power density in watts per square meter, ω is the angular frequency and $Z_1 - Z_2$ is the difference in propagation distance of each beam.

If we now define:

$$G_3 = \frac{1}{G^{(0)}}(G_1 + G_2)(G_1^* + G_2^*) \tag{11}$$

$$\Box G_3 = B \neq 0 \tag{12}$$

and a fluctuating magnetic flux density magnitude appears in the zone of interference. Therefore so does a fluctuating electric field strength magnitude $E = cB$. Outside the sone of interference, the fluctuating B and E disappear again.

The heat due to the scalar beams and the fluctuating E and B should be detectible. Note that eqn. (12) is a gauge invariant construct and so the B and E produced in the interference zone are real and physical. The energy density En/V is also gauge invariant and fluctuates in the interference zone:

$$\frac{En}{V} = \frac{B^{(0)2}}{\mu_0} = \frac{GG^*}{R^4 \mu_0} \tag{13}$$

because $B^{(0)}$ is a magnetic flux density and G is a magnetic flux, with R^2 as the beam area. The lateral extent of the beam is constrained by the inverse lateral distance raised to the fourth power. Of course, if R is constant, it is not infinitely expanding. So X and Y are constrained by $X^2 + Y^2 = R^2$.

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DOUBLE DIPOLE ANTENNA SOLUTION

Set up two dipole antennae **equal and opposite**:

$$A_1 = -i\frac{\kappa e^{i\kappa r}}{4\pi c\varepsilon_0 r}p_1 \tag{1}$$

$$A_2 = i\frac{\kappa e^{i\kappa r}}{4\pi c\varepsilon_0 r}p_2 \tag{2}$$

where $\boldsymbol{p}_1$ and $\boldsymbol{p}_2$ are the dipole moments, r is the radius vector and κ is the wave-vector.

Then

$$\begin{aligned} \boldsymbol{A} = \boldsymbol{A}_1 + \boldsymbol{A}_2 = \boldsymbol{0} \\ \boldsymbol{E} = \boldsymbol{B} = \boldsymbol{0} \end{aligned} \tag{3}$$

and

$$\dot{\boldsymbol{f}}_1 = -\dot{\boldsymbol{f}}_2; \qquad \boldsymbol{g}_1 = -\boldsymbol{g}_2 \tag{4}$$

$$\dot{\boldsymbol{F}}_1^2 = \dot{\boldsymbol{F}}_2^2; \qquad \boldsymbol{G}_1^2 = \boldsymbol{G}_2^2 \tag{5}$$

In the radiation zone:

$$G = \frac{A^{(0)}}{\sqrt{2}}\left(X - iY\right)e^{i(\omega t - \kappa Z)} \tag{6}$$

$$\phi_L = \dot{G} \tag{7}$$

$$\Box G_1 = \Box G_2 = 0$$

$$H = \frac{2}{\mu_0}\int \boldsymbol{B}^{(3)} \cdot \boldsymbol{B}^{(3)*} dV \tag{8}$$

This energy represents a stream of photons without fields in free space. As soon as these photons interact with electrons, fields reappear through the principles of quantum electrodynamics. These photons cannot be detected by antennae set up to detect fields until the photons hit the antenna. The heat associated with the energy (δ) can be made to be very intense if the transmitter is very powerful. The double dipole antenna is oriented in the same way as a single dipole antenna, thus collimating the beam of photons.

The analysis is based on the very simple fact that if two vectors have the property $\boldsymbol{A} = -\boldsymbol{B}$ then $\boldsymbol{A}$ and $\boldsymbol{B}$ are **equal in magnitude** but opposite in direction.